GRANT-FREE TRANSMISSION METHOD, USER EQUIPMENT, ACCESS NETWORK DEVICE, AND CORE NETWORK DEVICE

TECHNICAL FIELD

[0001] Embodiments of the present invention relate to the field of communications technologies, and in particular, to a grant-free transmission method, user equipment, an access network device, and a core network device.

BACKGROUND

[0002] In a Long Term Evolution (LTE) system, when user equipment (UE) needs to transmit uplink data, the user equipment uses an uplink scheduling request (SR) mechanism. The UE sends an uplink scheduling request to a base station, and informs the base station that the UE requires an uplink resource for data transmission. After receiving the scheduling request from the UE, the base station allocates specific resources to the UE. The UE transmits data on the allocated resources.

[0003] Development of the Internet of Things has resulted in an increasing quantity of machine type communication (Machine Type Communication, MTC) services. For an MTC service, generally, a data packet is relatively small, and a relatively low transmission delay is required. When a large quantity of MTC services exist, the foregoing scheduling request mechanism not only causes high signaling overheads but also leads to a transmission delay.

[0004] To resolve the foregoing problem, a technical solution of uplink grant-free (Grant Free) transmission has been proposed. Grant free means that, in a public land mobile network (Public Land Mobile Network, PLMN), UE does not need to use a scheduling request to request a base station to allocate a resource for data transmission. A grant free user can directly transmit a packet on a contention transmission unit

(CTU) in a grant-free transmission mode according to different characteristics, such as transmission delay requirements or transmission reliability requirements, of to-be-transmitted data.

[0005] In an existing LTE system, user equipment needs to establish a radio resource control (RRC) connection to a wireless communications network during communication. In addition, a mobility management entity (MME) completes authentication of the user equipment according to user equipment information recorded on a home location register (Home Location Register, HLR). A bearer channel needs to be established between the user equipment, a base station, a serving gateway (Serving Gateway, S-GW), and a public data network (Public Data Network, PDN) gateway (PDN Gateway, P-GW), so as to transmit a service data flow over the established bearer channel. Moreover, a protocol stack context, including a Packet Data Convergence Protocol (Packet Data Convergence Protocol, PDCP) entity, a radio link control (RLC) entity, a Medium Access Control (MAC) entity, a physical layer (PHY) entity, and the like, further needs to be established for the user equipment and a network device. To ensure integrity and security of data transmission, the user equipment performs integrity protection and an encryption and decryption process on the PDCP entity.

[0006] In a grant-free (Grant Free, GF) transmission scenario, user equipment may be in an idle state or may be in a connected state. In the connected state, the user equipment and a network device can maintain context resources required for air-interface transmission, that is, PDCP, RLC, MAC, and PHY entities, so as to ensure integrity and security of data transmission. In this case, redundant additional information of a protocol stack results in a decrease in transmission efficiency. In the idle state, the user equipment does not need to establish an RRC connection to a network side, and can directly transmit a packet on a contention transmission unit (CTU) in a grant-free transmission mode. This technical solution is simple and effective, but it does not take data transmission security into consideration.

[0007] Therefore, how to implement simple, effective, and secure communication in a grant-free transmission scenario is a problem that urgently needs to be resolved.

[0048] With reference to the first or the second possible implementation of the sixth aspect, in a third possible implementation, the sending module further sends indication information of the multiple CTU resources to the user equipment.

[0049] With reference to any one of the foregoing possible implementations of the sixth aspect, in a fourth possible implementation, the first request message is a non-access stratum message/an attach message, the non-access message/attach message includes a register grant-free request field, the first response message is a non-access accept message/an attach accept message, and the non-access accept message/attach accept message includes a register grant-free response field; or the first request message is a register grant-free request message, and the first response message is a registration response message.

[0050] With reference to any one of the foregoing possible implementations of the sixth aspect, in a fifth possible implementation, the core network device is an independent physical device with a low-delay service function, or the core network device is a mobility management entity, where the mobility management entity includes a low-delay service function entity.

[0051] Based on the foregoing technical solutions, user equipment obtains, from a core network device, a user equipment identifier and a key that are specially used for grant-free transmission, encrypts and encapsulates to-be-transmitted data by using the user equipment identifier and the key, and transmits the data on a CTU resource in a grant-free transmission mode. Because redundant additional information of a protocol stack is avoided, simple and effective communication is implemented. Moreover, using a dedicated user identifier and a dedicated key ensures packet transmission security. Therefore, simple, effective, and secure communication is implemented in a grant-free transmission scenario.

BRIEF DESCRIPTION OF DRAWINGS

[0052] To describe the technical solutions in the embodiments of the present invention more clearly, the following briefly describes the accompanying drawings required for describing the embodiments. Apparently, the accompanying drawings in the following description show merely some embodiments of the present invention, and a person

[0067] FIG. 15 is a schematic structural diagram of a core network device according to another embodiment of the present invention; and

[0068] FIG. 16 is a schematic structural diagram of an access network device according to another embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[0069] The following clearly describes the technical solutions in the embodiments of the present invention with reference to the accompanying drawings in the embodiments of the present invention. Apparently, the described embodiments are a part rather than all of the embodiments of the present invention. All other embodiments obtained by a person of ordinary skill in the art based on the embodiments of the present invention without creative efforts shall fall within the protection scope of the present invention.

[0070] Terms such as "component", "module", and "system" used in this specification are used to indicate computer-related entities, hardware, firmware, combinations of hardware and software, software, or software being executed. For example, a component may be but is not limited to a process that runs on a processor, a processor, an object, an executable file, a thread of execution, a program, and/or a computer. As shown in figures, both an application that runs on a computing device and a computing device may be components. One or more components may reside within a process and/or a thread of execution, and a component may be located on one computer and/or distributed between two or more computers. In addition, these components may be executed from various computer readable media that store various data structures. The components may communicate by using a local and/or remote process and according to, for example, a signal having one or more data packets (for example, data from a component interacting with another component in a local system, a distributed system, and/or across a network such as the Internet interacting with another system by using the signal).

[0071] It should be understood that, the technical solutions in the embodiments of the present invention may be applied to various communications systems, for example, a Global System for Mobile Communications ("GSM" for

short) system, a Code Division Multiple Access ("CDMA" for short) system, a Wideband Code Division Multiple Access ("WCDMA" for short) system, a Long Term Evolution ("LTE" for short) system, an LTE frequency division duplex ("FDD" for short) system, an LTE time division duplex ("TDD" for short), a Universal Mobile Telecommunications System ("UMTS" for short), and a future 5G communications system.

[0072] The present invention describes the embodiments with reference to a terminal device. The terminal device may also be user equipment ("UE" for short), an access terminal, a subscriber unit, a subscriber station, a mobile station, a mobile station, a remote station, a remote terminal, a mobile device, a user terminal, a terminal, a wireless communications device, a user agent, or a user apparatus. The access terminal may be a cellular phone, a cordless phone, a Session Initiation Protocol ("SIP" for short) phone, a wireless local loop "WLL" for short) station, a personal digital assistant ("PDA" for short), a handheld device with a wireless communication function, a computing device, another processing device connected to a wireless modem, an in-vehicle device, a wearable device, a terminal device in a future 5G network, a terminal device in a future evolved PLMN network, or the like.

[0073] The present invention describes the embodiments with reference to a network device. The network device may be a device configured to communicate with a terminal device. For example, the network device may be a base transceiver station ("BTS" for short) in a GSM system or in a CDMA system, may be a NodeB (NodeB, "NB" for short) in a WCDMA system, or may be an evolved NodeB ("eNB" or "eNodeB" for short) in an LTE system. Alternatively, the network device may be a relay station, an access point, an in-vehicle device, a wearable device, a core network device in a future 5G network, a network device in a future evolved PLMN network, or the like.

[0074] In addition, aspects or features of the present invention may be implemented as a method, an apparatus, or a product that uses standard programming and/or engineering technologies. The term "product" used in this application covers a computer program that can be accessed from any computer readable component, carrier, or medium. For example, the

computer readable medium may include but is not limited to: a magnetic storage device (for example, a hard disk, a floppy disk, or magnetic tape), an optical disc (for example, a CD (Compact Disk) or a DVD (Digital Versatile Disk), a smart card, and a flash memory device (for example, an EPROM (Erasable Programmable Read-Only Memor), a card, a stick, or a key drive). In addition, various storage media described in this specification may indicate one or more devices and/or other machine-readable media configured to store information. The term "machine-readable media" may include but is not limited to a radio channel, and various other media that can store, contain, and/or bear an instruction and/or data.

[0075] In an existing cellular communications system, such as a GSM system, a WCDMA system, or an LTE system, supported communication is mainly for voice and data communication. Generally, a quantity of connections supported by a conventional base station is limited and is easy to implement.

[0076] A next-generation mobile communications system not only supports conventional communication but also supports machine-to-machine ("M2M" for short) communication which is also referred to as machine type communication ("MTC" for short). It is predicted that, in 2020, there will be 50 billion to 100 billion MTC devices connected over a network. This greatly exceeds a current quantity of connections. For M2M, because of its diversified types of services, requirements for networks are greatly different. Roughly, there may exist the following several requirements: (I) reliable transmission, but insensitive to a delay; (II) a low delay, and highly reliable transmission.

[0077] A service that requires reliable transmission but is insensitive to a delay is relatively easy to handle. However, for a service that requires a low delay and highly reliable transmission, such as a V2V (English full name: Vehicle to Vehicle) service, it is required that a transmission delay should be low and transmission should be reliable. If transmission is unreliable, retransmission is caused. As a result, the transmission delay is excessively high, and requirements cannot be met.

[0078] Existence of a large quantity of connections makes a future wireless communications system differ greatly from an existing communications system. A large

drive). In addition, various storage media described in this specification may indicate one or more devices and/or other machine-readable media configured to store information. The term "machine-readable media" may include but is not limited to a radio channel, and various other media that can store, contain, and/or bear an instruction and/or data.

[0085] In an existing cellular communications system, such as a Global System for Mobile Communications (GSM for short) system, a Wideband Code Division Multiple Access (WCDMA for short) system, or a Long Term Evolution (LTE for short) system, supported communication is mainly for voice and data communication. Generally, a quantity of connections supported by a conventional base station is limited and is easy to implement.

[0086] A next-generation mobile communications system not only supports conventional communication but also supports M2M (Machine to Machine) communication which is also referred to as MTC (Machine Type Communication) communication. It is predicted that, by 2020, a quantity of MTC devices connected to networks will be up to 50 billion to 100 billion, a quantity far greater than a quantity of existing connections. For M2M, because of its diversified types of services, requirements for networks are greatly different. Roughly, there may exist the following several requirements: reliable transmission, but insensitive to a delay; and a low delay, and highly reliable transmission. A service that requires reliable transmission but is insensitive to a delay is relatively easy to handle. However, for a service that requires a low delay and highly reliable transmission, such as a V2V (Vehicle to Vehicle) service, it is required that a transmission delay should be low and transmission should be reliable. If transmission is unreliable, retransmission is caused. As a result, the transmission delay is excessively high, and requirements cannot be met.

[0087] Existence of a large quantity of connections makes a future wireless communications system differ greatly from an existing communications system. A large quantity of connections need to consume more resources for terminal device access and for scheduling signaling transmission that is related to data transmission by a terminal device.

[0088] FIG. 1 is a simplified schematic network diagram. In a network 100, there is, for example, a network device 102. The network device 102 is connected to terminal devices 104 to 114 (referred to as UE for short in the figure) in a wireless manner, a wired manner, or another manner.

[0089] A network in this patent may be a public land mobile network (PLMN for short), a D2D network, an M2M network, or another network. FIG. 1 is merely a simplified schematic diagram used as an example. A network may further include another network device, which is not shown in FIG. 1.

[0090] A terminal device in this patent application may also be user equipment (UE for short), an access terminal, a subscriber unit, a subscriber station, a mobile station, a mobile station, a remote station, a remote terminal, a mobile device, a user terminal, a terminal, a wireless communications device, a user agent, or a user apparatus. The access terminal may be a cellular phone, a cordless phone, a Session Initiation Protocol (SIP for short) phone, a wireless local loop (WLL for short) station, a personal digital assistant (PDA for short), a handheld device with a wireless communication function, a computing device, another processing device connected to a wireless modem, an in-vehicle device, a wearable device, a terminal device in a future 5G network, a terminal device in a future evolved PLMN network, or the like.

[0091] A network device in this patent application may be a device configured to communicate with a terminal device. The network device may be a BTS (Base Transceiver Station) in GSM or Code Division Multiple Access (Code Division Multiple Access, CDMA for short), may be an NB (NodeB) in WCDMA, may be a wireless controller in a cloud radio access network (CRAN for short) scenario, or may be an eNB or eNodeB (Evolutional Node B) in LTE. Alternatively, the network device may be an access point, an in-vehicle device, a wearable device, a network-side device in a future 5G network, a network device in a future evolved PLMN network, or the like.

[0092] To deal with a large quantity of MTC services in a future network and satisfy low-delay and high-reliability service transmission, this patent proposes a grant-free

understood as follows: Two or more terminal devices are allowed to perform uplink data transmission on a same time-frequency resource. Optionally, the transmission resource may be a transmission resource in one or more transmission time units following a time point at which the UE receives the signaling. One transmission time unit may be a minimum time unit of one transmission, for example, a TTI (Transmission Time Interval), and its value may be 1 ms. Alternatively, one transmission time unit may be a preset transmission time unit.

[0097] Grant-free transmission may mean: A terminal device performs uplink data transmission without being granted by a network device. The grant may mean: A terminal device sends an uplink scheduling request to a network device; after receiving the scheduling request, the network device sends an uplink grant to the terminal device, where the uplink grant indicates an uplink transmission resource allocated to the terminal device.

[0098] 6. Grant-free transmission may mean a contention-based transmission mode, and may specifically mean that multiple terminals simultaneously perform uplink data transmission on a same preallocated time-frequency resource without being granted by a base station.

[0099] The data may include service data or signaling data.

[0100] The blind detection may be understood as detection performed, when it is unknown in advance whether data arrives, on data that may arrive. The blind detection may also be understood as detection performed without explicit signaling indication.

[0101] The transmission resource may include but is not limited to one or a combination of the following resources:

a time domain resource, such as a radio frame, a subframe, and a symbol;

a frequency domain resource, such as a subcarrier and a resource block;

a space domain resource, such as an transmit antenna and a beam;

a code domain resource, such as a sparse code multiple access (SCMA for short) codebook group, a Low Density Signature (English full name: Low Density Signature, LDS for short) group, and a CDMA code group; or

an uplink pilot resource.

[0102] The foregoing transmission resource may be used for transmission performed according to a control mechanism including but not limited to the following:

uplink power control, such as control of an upper limit of uplink transmit power;

modulation and coding scheme setting, such as transport block size setting, code rate setting, or modulation order setting; and

a retransmission mechanism, such as a HARQ mechanism.

[0103] A contention transmission unit (CTU for short) may be a basic transmission resource for grant-free transmission. The CTU may be a transmission resource with a combination of a time, frequency, and code domain resource, may be a transmission resource with a combination of a time, frequency, and pilot resource, or may be a transmission resource with a combination of a time, frequency, code domain, and pilot resource.

[0104] A CTU access region may be a time-frequency resource region used for grant-free transmission.

[0105] A patent application numbered PCT/CN2014/073084 and entitled "System and Method for Uplink Grant-Free Transmission Scheme" provides a technical solution of uplink grant-free transmission. The application PCT/CN2014/073084 describes that a radio resource may be divided into various CTUs and that data of UE is mapped to a CTU. One code group may be allocated to each CTU. The allocated code group may be a group of CDMA codes, or may be an SCMA codebook set, an LDS group, a signature (signature) group, or the like. Each code may be corresponding to one pilot group. A user may select one code and one pilot in a pilot group corresponding to the code, to perform uplink transmission. Content of the application PCT/CN2014/073084 may be understood as a part incorporated into content of the embodiments of the present invention by reference, and details are not described.

[0106] When performing grant-free transmission, a terminal device may be in a connected state or may be in an idle state. In the idle state, because context resources on the terminal device and a network device have been released, when the terminal device transmits a packet in a grant-free transmission mode, an encryption and decryption key used in the connected state cannot be used. Therefore, data transmission security cannot be ensured. In addition, in the grant-free transmission mode, redundant additional information of a protocol stack resulting in reduction of transmission efficiency is unwanted. A protocol stack should be as simple and effective as possible. Moreover, a network device in a connected state

identifies a user by temporarily allocating a cell radio network temporary identifier (C-RNTI) to a terminal device. However, in the idle state, the CRNTI used in the connected state cannot be used in GF transmission to identify a user. When the terminal device performs GF transmission, if an application-layer IP packet is directly forwarded without any encapsulation, simple and high-efficiency transmission can be implemented. However, in GF transmission, a CTU resource is not allocated by a base station to a terminal device for use alone, but may be contended for by multiple terminal devices simultaneously for use. This easily results in packet masquerading or attack by another terminal device, affecting security.

[0107] FIG. 2 is a schematic architecture diagram of a communications system 200 according to another embodiment of the present invention.

[0108] The system 200 includes a low-delay service function (LDSF) entity 210, a base station 230, an MME/HLR/a home subscriber server (Home Subscriber Server, HSS) 120, a serving gateway (S-GW)/public data network gateway (P-GW) 250, and other network nodes. User equipment 240 communicates with the base station 230 by using an air interface. The LDSF 210 may be a logical function entity, or may be an actual physical device. The LDSF is mainly responsible for two sub-functions of grant-free transmission: a function of performing identity registration for user equipment that supports grant-free transmission, and a function of distributing data (for example, a packet) that is transmitted in a grant-free manner.

[0109] For example, when the user equipment performs grant-free transmission, the user equipment requests, to the LDSF by using the base station, to register a grant-free transmission identity, and the LDSF allocates, to the user equipment, a key and a user equipment identifier that are specially used for grant-free transmission. The user equipment encrypts and encapsulates data by using the key and the user equipment identifier, and transmits the data in a grant-free transmission mode. After receiving the data that is transmitted by the user equipment in the grant-free transmission mode, the base station sends the data to the LDSF. The LDSF distributes the data according to a destination address carried in the data.

[0110] It should be understood that the LDSF in this embodiment of the present invention may be a logical function entity of an MME or of another core network device. For convenience of description, the following provides descriptions by using an example in which an LDSF is an independent physical device, unless otherwise specified.

[0111] It should be understood that the system 200 may include at least one LDSF. Each base station is connected to at least one LDSF. After the base station is started, a transmission channel for a packet that is transmitted in a grant-free manner is maintained between the base station and the LDSF. For example, when the LDSF is a logical function entity of an MME, an interface between the LDSF and a network device is an S1 interface; when the LDSF is an independent physical device, the LDSF and a network device may be connected by using an interface similar to an S1 interface.

[0112] It should be further understood that, for the embodiment in FIG. 1, descriptions are provided by using an example in which a network device is a base station. Alternatively, the network device may be another access device (for example, a radio access point).

[0113] FIG. 3 is a schematic diagram of a CTU resource definition according to an embodiment of the present invention.

[0114] FIG. 3 shows four contention access regions (also referred to as CTU access regions) 310, 320, 330, and 340. Available bandwidth is divided into time-frequency regions of the four contention access regions. Each contention access region may occupy a preset quantity of resource blocks (Resource Block). For example, in the embodiment in FIG. 3, the contention access region 310 includes four RBs: an RB 1, an RB 2, an RB 3, and an RB 4. This embodiment of the present invention is not limited thereto. For example, different contention access regions may include different quantities of RBs. In FIG. 3, each contention access region can support 36 UEs contending for 36 CTUs defined in the contention access region. Each CTU is a combination of time, a frequency, a code resource or a signature, and a pilot. The code resource includes a CDMA code, an SCMA (Sparse Code Multiple Access) code, an LDS (Low Density Signature), another signature (signature), or the like. Each contention access region occupies one time-frequency resource region. Each time-frequency resource region supports six signatures (S1 to S6), and each signature is mapped to six pilots, thereby

generating a total of 36 pilots (P1 to P36). A network device may detect or decode, by using a pilot/signature decorrelator, a signal sent by each UE on a CTU.

[0115] When UE enters a coverage area of a source network device, the UE can receive higher layer signaling sent by the network device. The higher layer signaling may carry a CTU access region definition (CTU access region definition), a total quantity of CTUs, a default mapping rule, and the like. Alternatively, the UE may preconfigure a default mapping rule. The UE may determine an appropriate CTU to perform grant-free transmission on the CTU. When different UEs perform grant-free transmission on a same CTU, that is, contend for a same CTU, a collision occurs. The UE may determine, according to an indication from the network device, whether a collision exists. For example, a problem resulting from a collision can be resolved by using an asynchronous HARQ method. However, if a quantity of collisions exceeds a preset threshold, the UE may request, to the network device, to remap data to a CTU. The network device sends information about a to-be-remapped-to CTU to the UE, so that the UE performs grant-free transmission on the remapped-to CTU.

[0116] It should be understood that, for convenience of description, FIG. 3 shows four contention access regions. This embodiment of the present invention is not limited thereto. More or fewer contention access regions may be defined according to a need.

[0117] FIG. 4 is a schematic flowchart of a grant-free transmission method according to an embodiment of the present invention. For example, the method in FIG. 4 may be executed by the user equipment in FIG. 2. An access network device in this embodiment may be the network device in FIG. 2.

[0118] 410: The user equipment obtains a user equipment identifier and a key that are allocated by a core network device and that are used for grant-free transmission.

[0119] 420: The user equipment encrypts and encapsulates data by using the key and the user equipment identifier.

[0120] 430: The user equipment transmits the encrypted and encapsulated data to the access network device on a first contention transmission unit CTU resource in a grant-free transmission mode.

[0121] Specifically, the user equipment registers a grant-free transmission identity with the core network device by using the access network device, so that the core network device

[0129] For example, the first request message may be a/an non-access stratum/attach ((Non-Access Stratum, NAS)/Attach) request message. A difference from a conventional non-access stratum/attach request message lies in that, the non-access request message/attach request message in this embodiment of the present invention may include a register grant-free request (REGISTER_GF_REQ) field. The register grant-free request field is used to indicate that the user equipment supports grant-free transmission and to request the core network device to allocate, to the user equipment, the user equipment identifier and the key that are used for grant-free transmission. Therefore, the core network device that receives the register grant-free request field knows that the user equipment supports a grant-free transmission function, and then allocates, to the user equipment, the user equipment grant-free identifier and the grant-free key that are required for grant-free transmission.

[0130] For example, the first response message may be a/an non-access/attach accept (NAS/Attach accept) message. A difference from a conventional non-access stratum/attach accept message lies in that, the non-access accept message/attach accept message may include a register grant-free response (REGISTER_GF_RESP) field. The register grant-free response field carries the user equipment identifier and the key. In this embodiment, the register grant-free request and the register grant-free response are implemented by using existing signaling, thereby reducing signaling overheads.

[0131] Alternatively, in another embodiment, the first request message may be a dedicated register grant-free request message, and the first response message may be a dedicated registration response message.

[0132] For example, in an idle state, when the user equipment cannot use a non-access stratum request message/an attach request message and a non-access accept message/an attach accept message, the user equipment may perform registration by using a dedicated register grant-free request message and a dedicated registration response message.

[0133] In step 430, the user equipment selects the first CTU resource from multiple contention transmission unit CTU resources, and maps the data to the first CTU resource for transmission.

[0134] In a grant-free transmission scenario, each contention transmission access region may include multiple CTUs. The UE may select at least one appropriate CTU according to a

access network device, where the SIB message carries the public key. The user equipment extracts the public key from the received SIB message, and encrypts the first request message by using the public key. The user equipment may select an appropriate CTU, and map the first request message encrypted in a grant-free manner to the selected CTU, to send the first request message to the access network device. The access network device performs blind detection, and sends the detected first request message to the core network device. The core network device decrypts the first request message by using the private key, performs authentication on the user equipment according to the decrypted first request message, and allocates, to the user equipment, the user identifier and the key that are specially used for grant-free transmission. The core network device encrypts, by using the private key, the first response message that includes the user equipment identifier and the key, and sends the encrypted first response message to the user equipment by using the access network device. The user equipment decrypts the first response message by using the public key, to obtain the user equipment identifier and the key that are allocated by the core network device and that are specially used for grant-free transmission. For example, the access network device may send the first response message by using a broadcast message similar to an SIB message. In addition, the broadcast message may carry an identifier associated with a CTU that is used for sending the first request message, so that the user equipment can identify and receive the first response message.

[0140] In step 420, the user equipment encrypts and encapsulates the data at a transport adaptation layer of the user equipment by using the key and the user equipment identifier.

[0141] Optionally, in another embodiment, the method in FIG. 4 further includes: receiving, by the user equipment, indication information of the multiple CTU resources that is sent by the access network device, where the indication information is used to indicate the CTU resources that can be used by the user equipment.

[0142] For example, the access network device may broadcast, over a broadcast channel, the indication information of the multiple CTU resources to the user equipment within coverage of the access network device. The user equipment may select at least one

[0158] According to this embodiment of the present invention, the core network device is an independent physical device with a low-delay service function, or the core network device is a mobility management entity, where the mobility management entity includes a low-delay service function entity.

[0159] FIG. 6 is a schematic flowchart of a grant-free transmission method according to still another embodiment of the present invention. The method in FIG. 6 is executed by the access network device in FIG. 1. The embodiment in FIG. 6 corresponds to the embodiment in FIG. 4. Some details are omitted herein as appropriate. In this embodiment, descriptions are provided by using an example in which an access network device is the access network device in FIG.1.

[0160] 610: The access network device receives a first request message from user equipment, where the first request message is used to indicate that the user equipment supports grant-free transmission and to request a core network device to allocate, to the user equipment, a user equipment identifier and a key that are used for grant-free transmission.

[0161] 620: The access network device sends the first request message to the core network device.

[0162] 630: The access network device receives a first response message sent by the core network device, where the first response message carries the user equipment identifier and the key.

[0163] 640: The access network device sends the first response message to the user equipment, so that the user equipment encrypts and encapsulates data by using the key and the user equipment identifier.

[0164] 650: The access network device receives the data that is transmitted by the user equipment to the access network device on a first contention transmission unit CTU resource in a grant-free transmission mode.

[0165] 660: The access network device sends the data to the core network device.

[0166] According to this embodiment of the present invention, an access network device provides, for user equipment, a user equipment identifier and a key that are allocated by a core network device and that are specially used for grant-free transmission, receives data that is transmitted by the user equipment on a CTU resource in a grant-free transmission mode,

[0173] The following describes a grant-free transmission process in detail with reference to embodiments in FIG. 7, FIG. 8, and FIG. 9. FIG. 9 is a schematic diagram of a signaling flow used for grant-free transmission according to another embodiment of the present invention. Referring to FIG. 9, the following signaling process is executed in both the embodiments in FIG. 7 and FIG. 8: UE sends a register grant-free request (REGISTER_GF_REQ) to an LDSF, and the LDSF sends a register grant-free response (REGISTER_GF_RESP) to the UE, so that the LDSF allocates, to the user equipment, a user equipment identifier and a key that are used for grant-free transmission.

[0174] FIG. 7 is a schematic flowchart based on a grant-free transmission process according to another embodiment of the present invention. The process in FIG. 7 is an example of the methods in FIG. 4, FIG. 5, and FIG. 6. Some details are omitted herein as appropriate. In FIG. 7, descriptions are provided by using an example in which an access network device is an eNB. The eNB represents a control base station of a cell that UE currently serves. However, the present invention is not limited to a specific standard represented by the term, but may be similarly applied to base stations of other standards.

[0175] In this embodiment, how to implement grant-free transmission when user equipment is in a connected state is described. In this embodiment, the user equipment supports both conventional grant-based transmission and grant-free transmission. That is, grant-based transmission and grant-free transmission are compatible in the user equipment, and therefore, transition from grant-based transmission to grant-free transmission can be provided. For example, generally, when the user equipment performs grant-based transmission, when a condition for grant-free transmission is met (for example, a preset condition is met or a switching instruction is received), the user equipment switches from grant-based transmission to grant-free transmission.

[0176] When grant-free transmission needs to be performed, user equipment supporting a grant-free transmission function may establish a connection to an LDSF by means of a process of requesting to register for grant-free transmission. By means of the process, the LDSF may allocate, to the user equipment, a user equipment grant-free identifier (UE_GF_ID) and a grant-free key (GF_KEY) that are used for grant-free transmission.

message. For example, the UEID may be an international mobile subscriber identity (IMSI), an international mobile equipment identity (IMEI), or the like.

[0182] If the register grant-free request message is a newly added dedicated signaling message, when the LDSF needs to identify the user equipment, the LDSF may directly obtain the UEID from the register grant-free request message. If the register grant-free request message is a REGISTER_GF_REQ message field in a non-access stratum request message/an attach request message, the UEID does not need to be carried in the REGISTER_GF_REQ message field; the LDSF may indirectly obtain the UEID from another message field in the non-access stratum request message/attach request message.

[0183] 750: The eNB forwards the register grant-free request message to the LDSF.

[0184] The user equipment may send the register grant-free request message to the LDSF by using an air interface. That is, the user equipment first sends the register grant-free request message to the eNB, and then, the eNB forwards the register grant-free request message to the LDSF over a channel between the eNB and the LDSF. The channel between the eNB and the LDSF may be established when the eNB is started, and is similar to an S1 interface between the eNB and an MME. Because the LDSF needs to identify different user equipments, alternatively, the eNB may add the UEID to the register grant-free request message, and the user equipment does not need to add the UEID to the register grant-free request message when sending the register grant-free request. This can reduce resources used in air-interface transmission. Certainly, as described above, the register grant-free request message sent by the user equipment to the eNB may directly carry the UEID. In this case, the eNB transparently transmits the register grant-free request message to the LDSF.

[0185] 760: The LDSF performs authentication (Authority), authentication (Authentication), and security (Security) processes with an HLR/HSS.

[0186] When receiving the register grant-free request message forwarded by the eNB, the LDSF performs the identity authentication and authentication processes on the user equipment according to the UEID indicated by the register grant-free request message. After identity authentication of the user equipment succeeds and it is confirmed that the user equipment has grant-free transmission permission, the LDSF allocates the user equipment grant-free identifier (UE_GF_ID) to the user equipment. Then, the LDSF further performs the

security process to allocate, to the user equipment, the grant-free key (GF_KEY) that is required for grant-free transmission and that is used for data encryption and decryption.

[0187] If the register grant-free request message is a message field in a non-access stratum request message/an attach request message, the identity authentication, authentication, and security processes may be triggered by the non-access stratum request message/attach request message. Specifically, when receiving the non-access stratum request message/attach request message, the LDSF performs the identity authentication process according to the UEID. When authentication succeeds, the authentication process is performed to determine whether the user equipment has the grant-free transmission permission. In addition, the security process is performed to obtain the grant-free key that is required for grant-free transmission and that is used for encryption and decryption, and to allocate the user equipment grant-free identifier to the user equipment.

[0188] If the register grant-free request message is a newly added dedicated signaling message, the LDSF needs to perform identity authentication on the user equipment by means of the identity authentication process, and determine, by means of the authentication process, whether the user equipment has the grant-free transmission permission. If the user equipment has the grant-free transmission permission, the LDSF performs the security process to obtain the grant-free key that is required for grant-free transmission and that is used for encryption and decryption, and to allocate the user equipment grant-free identifier to the user equipment.

[0189] 770: The LDSF sends a register grant-free response message (REGISTER_GF_RESP) to the eNB.

[0190] The LDSF adds, to the register grant-free response message, the user equipment grant-free identifier (UE_GF_ID) and the grant-free key (GF_KEY) that are allocated to the user equipment. The register grant-free response message may be a newly added dedicated signaling message, or may be a REGISTER_GF_RESP message field newly added to an existing signaling message. For example, the register grant-free response message may be a field newly added to a non-access stratum accept message/an attach accept message. The REGISTER_GF_RESP is similar to the REGISTER_GF_REQ. When the REGISTER_GF_REQ is a message field in a non-access stratum request message/an attach request message, the REGISTER_GF_RESP is a message field in a non-access stratum

[0204] Specifically, after receiving the uplink packet that is transmitted by the user equipment in a grant-free manner and that is forwarded by the eNB, the LDSF decrypts the packet by using the grant-free key of the user equipment, and then distributes the decrypted packet to a destination (for example, an access network device corresponding to a destination address in the packet). When the LDSF performs a function of distributing the uplink packet that is transmitted in a grant-free manner, the LDSF may be an independent physical device, or may be an entity function of an S-GW or a P-GW. The LDSF manages distribution of uplink packets that are transmitted in a grant-free manner and that are from multiple eNBs in a network. The LDSF establishes, with each eNB, a dedicated transmission channel for an uplink packet that is transmitted in a grant-free manner. All uplink packets of user equipment, that are transmitted in a grant-free manner, in the eNB are transmitted over the transmission channel. After receiving the uplink packet that is transmitted by the user equipment in a grant-free manner and that is forwarded by the base station, the LDSF decrypts the packet by using the grant-free key of the user equipment, and then distributes the decrypted packet to the destination (for example, an access network device corresponding to a destination address in the packet).

[0205] FIG. 8 is a schematic flowchart based on a grant-free transmission process according to another embodiment of the present invention. The process in FIG. 8 is an example of the methods in FIG. 3, FIG. 4, and FIG. 5. Some details are omitted herein as appropriate. In FIG. 8, descriptions are provided by using an example in which an access network device is an eNB. The eNB represents a control base station of a cell that UE currently serves. However, the present invention is not limited to a specific standard represented by the term, but may be similarly applied to base stations in other forms.

[0206] In this embodiment, how to implement grant-free transmission when user equipment is in an idle state or does not establish an RRC connection to a network side is described. In the idle state, the user equipment supports only grant-free transmission and does not support grant-based transmission. For example, the user equipment may be a machine type communication (MTC) device that has very high requirements on a transmission delay, reliability, power consumption, and the like and that has a low requirement on a transmission rate. When transmitting a packet, the user equipment

does not need to establish a connection to a network in advance, and does not require that the network allocate, to the user equipment, a dedicated time-frequency resource required for transmission. All packets or messages are transmitted in a grant-free transmission mode.

[0207] When performing grant-free transmission, the user equipment may establish a connection to an LDSF by means of a process of requesting to register for grant-free transmission. By means of the process, the LDSF may allocate, to the user equipment, a user equipment grant-free identifier (UE_GF_ID) and a grant-free key (GF_KEY) that are used for grant-free transmission.

[0208] 810: The eNB informs the user equipment of a grant-free CTU resource.

[0209] For example, the eNB may periodically broadcast, over a broadcast channel, the CTU resource used for grant-free transmission. The eNB may broadcast multiple CTU resources once, to form a CTU resource set. These CTU resources may be distributed in one radio frame. One radio frame may include multiple transmission timeslots, and occupies specific frequency domain resources. One CTU resource is a part of a time-frequency resource in one transmission timeslot. Different CTU resources are not completely the same in respect of time-frequency resources, codebooks, pilots, and the like. The user equipment may randomly select a CTU resource or may select a CTU resource according to a preset rule, and transmit an uplink packet by using a time-frequency resource, a code resource, a pilot, and other transmission parameters specified by the CTU resource. When multiple user equipments simultaneously select a same CTU resource for uplink transmission, a transmission relationship based on contention for the resource is formed.

[0210] It should be understood that this embodiment of the present invention does not limit a sequence in which the eNB informs the user equipment of the CTU resource. The eNB may inform the user equipment of the CTU resource at any time point before the user equipment transmits an uplink packet.

[0211] 820: The LDSF sends a grant-free register public key (GF_REG_PUB_KEY) to the eNB.

[0212] The LDSF may generate a key pair including a pair of the public key and a private key, and send the public key to all eNBs that are within control of the LDSF. The public key is used to encrypt information, and is used to decrypt information encrypted by using the private key.

[0259] FIG. 12 is a schematic structural diagram of a core network device 1200 according to an embodiment of the present invention. The core network device 1200 includes a receiving module 1210, a decapsulation module 1220, a decryption module 1230, and a sending module 1240.

[0260] The receiving module 1210 is configured to receive, from an access network device, data transmitted by user equipment on a first contention transmission unit in a grant-free transmission mode, where the data is encrypted and encapsulated by using a key and a user equipment identifier that are allocated by the core network device to the user equipment and that are used for grant-free transmission.

[0261] The decapsulation module 1220 is configured to decapsulate the data according to the user equipment identifier.

[0262] The decryption module 1230 is configured to decrypt the data according to the key.

[0263] The sending module 1240 is configured to send the decrypted data to a destination address in the data.

[0264] According to this embodiment of the present invention, a core network device provides, for user equipment, a user equipment identifier and a key that are specially used for grant-free transmission, and decapsulates and decrypts received data by using the user equipment identifier and the key. Because redundant additional information of a protocol stack is avoided, simple and effective communication is implemented. Moreover, using a dedicated user identifier and a dedicated key ensures data transmission security. Therefore, simple, effective, and secure communication is implemented in a grant-free transmission scenario.

[0265] Optionally, in another embodiment, the core network device further includes an allocation module 1250; the receiving module 1210 further receives a first request message from the user equipment by using the access network device, where the first request message is used to indicate that the user equipment supports grant-free transmission and to request the core network device to allocate, to the user equipment, the user equipment identifier and the key that are used for grant-free transmission; the allocation module 1250 allocates, to the user equipment, the user equipment identifier and the key that are used for grant-free transmission;

[0276] Optionally, in another embodiment, the sending module 1320 further sends indication information of the multiple CTU resources to the user equipment.

[0277] According to this embodiment of the present invention, the first request message is a non-access stratum message/an attach message, the non-access message/attach message includes a register grant-free request field, the first response message is a non-access accept message/an attach accept message, and the non-access accept message/attach accept message includes a register grant-free response field; or the first request message is a register grant-free request message, and the first response message is a registration response message.

[0278] According to this embodiment of the present invention, the core network device is an independent physical device with a low-delay service function, or the core network device is a mobility management entity, where the mobility management entity includes a low-delay service function entity.

[0279] For operations and functions of the modules of the access network device 1300, refer to the method in FIG. 6. To avoid repetition, details are not described herein again.

[0280] FIG. 14 is a schematic structural diagram of user equipment 1400 according to another embodiment of the present invention. The user equipment 1400 includes a processor 1410, a transceiver 1420, a memory 1430, and a bus 1440.

[0281] The processor 1410 is configured to invoke, by using the bus 1440, code stored in the memory 1430, so as to obtain a user equipment identifier and a key that are allocated by a core network device and that are used for grant-free transmission, encrypt data by using the key, and encapsulate the data by using the user equipment identifier. The transceiver 1420 is configured to transmit the encrypted and encapsulated data to an access network device on a first contention transmission unit CTU resource in a grant-free transmission mode.

[0282] According to this embodiment of the present invention, user equipment obtains, from a core network device, a user equipment identifier and a key that are specially used for grant-free transmission, encrypts and encapsulates to-be-transmitted data by using the user equipment identifier and the key, and transmits the data on a CTU resource in a grant-free transmission mode. Because redundant additional information of a protocol stack is avoided, simple and effective communication is implemented. Moreover, using a dedicated user

simple, effective, and secure communication is implemented in a grant-free transmission scenario.

[0295] Optionally, in another embodiment, the transceiver 1520 further receives a first request message from the user equipment by using the access network device, where the first request message is used to indicate that the user equipment supports grant-free transmission and to request the core network device to allocate, to the user equipment, the user equipment identifier and the key that are used for grant-free transmission; the processor 1510 further allocates, to the user equipment, the user equipment identifier and the key that are used for grant-free transmission; the transceiver 1520 further sends a first response message to the user equipment by using the access network device, where the first response message carries the user equipment identifier and the key.

[0296] Optionally, in another embodiment, the processor 1510 further generates a pair of a public key and a private key; the transceiver 1520 further sends the public key to the user equipment by using the access network device; the processor 1510 further decrypts, by using the private key, the first request message that includes the public key.

[0297] According to this embodiment of the present invention, the first request message is a non-access stratum message/an attach message, the non-access message/attach message includes a register grant-free request field, the first response message is a non-access accept message/an attach accept message, and the non-access accept message/attach accept message includes a register grant-free response field; or the first request message is a register grant-free request message, and the first response message is a registration response message.

[0298] According to this embodiment of the present invention, the processor 1510 decapsulates the data at an adaptation layer of the core network device by using the user equipment identifier and the key, and decrypts the data at the adaptation layer of the core network device by using the key.

[0299] According to this embodiment of the present invention, the core network device is an independent physical device with a low-delay service function, or the core network device is a mobility management entity, where the mobility management entity includes a low-delay service function entity.

[0305] Optionally, in another embodiment, the transceiver 1620 further receives a public key from the core network device. The transceiver 1620 further broadcasts the public key in a system information block SIB message. The transceiver 1620 receives the first request message that is encrypted by the user equipment by using the public key, and sends the encrypted first request message to the core network device. The transceiver 1620 receives the first response message that is encrypted by the core network device by using a private key.

[0306] Optionally, in another embodiment, the transceiver 1620 further sends indication information of the multiple CTU resources to the user equipment.

[0307] According to this embodiment of the present invention, the first request message is a non-access stratum message/an attach message, the non-access message/attach message includes a register grant-free request field, the first response message is a non-access accept message/an attach accept message, and the non-access accept message/attach accept message includes a register grant-free response field; or the first request message is a register grant-free request message, and the first response message is a registration response message.

[0308] According to this embodiment of the present invention, the core network device is an independent physical device with a low-delay service function, or the core network device is a mobility management entity, where the mobility management entity includes a low-delay service function entity.

[0309] For operations and functions of the modules of the access network device 1600, refer to the method in FIG. 6. To avoid repetition, details are not described herein again.

[0310] A person of ordinary skill in the art may be aware that units and algorithm steps with reference to the examples described in the embodiments disclosed in this specification may be implemented by electronic hardware or a combination of computer software and electronic hardware. Whether the functions are performed in a hardware manner or a software manner depends on specific applications and design constraint conditions of the technical solutions. A person skilled in the art may use different methods to implement the described functions for each specific application, but it should not be considered that such an implementation goes beyond the scope of the present invention.

[0311] It may be clearly understood by a person skilled in the art that, for the purpose of convenient and brief description, for detailed working processes of the foregoing system,

Read-Only Memory), a random access memory (RAM, Random Access Memory), a magnetic disk, or an optical disc.

[0316] The foregoing descriptions are merely specific implementations of the present invention, but the protection scope of the present invention is not limited thereto. Any variation or replacement readily figured out by a person skilled in the art within the technical scope disclosed in the present invention shall fall within the protection scope of the present invention. Therefore, the protection scope of the present invention shall be subject to the protection scope of the claims.

Embodiment 1: wherein the first request message is a non-access stratum message/an attach message, the non-access message/attach message comprises a register grant-free request field, the first response message is a non-access accept message/an attach accept message, and the non-access accept message/attach accept message comprises a register grant-free response field; or

the first request message is a register grant-free request message, and the first response message is a registration response message.

Embodiment 2: wherein the core network device is an independent physical device with a low-delay service function, or the core network device is a mobility management entity, wherein the mobility management entity comprises a low-delay service function entity.

Embodiment 3: 10. A grant-free transmission method, comprising:

receiving, by a core network device from an access network device, data transmitted by user equipment on a first contention transmission unit in a grant-free transmission mode, wherein the data is encrypted and encapsulated by using a key and a user equipment identifier that are allocated by the core network device to the user equipment and that are used for grant-free transmission;

decapsulating and decrypting, by the core network device, the data according to the user equipment identifier and the key; and

sending, by the core network device, the decrypted data to a destination address in the data.

11. The method according to claim 10, further comprising:

receiving, by the core network device, a first request message from the user equipment by using the access network device, wherein the first request message is used to indicate that the user equipment supports grant-free transmission and to request the core network device to allocate, to the user equipment, the user equipment identifier and the key that are used for grant-free transmission;

allocating, by the core network device to the user equipment, the user equipment identifier and the key that are used for grant-free transmission; and

sending, by the core network device, a first response message to the user equipment by using the access network device, wherein the first response message carries the user equipment identifier and the key.

12. The method according to claim 10 or 11, further comprising:

generating, by the core network device, a pair of a public key and a private key;

sending, by the core network device, the public key to the user equipment by using the access network device; and

decrypting, by the core network device by using the private key, the first request message that comprises the public key.

13. The method according to any one of claims 10 to 12, wherein the first request message is a non-access stratum message/an attach message, the non-access message/attach message comprises a register grant-free request field, the first response message is a non-access accept message/an attach accept message, and the non-access accept message/attach accept message comprises a register grant-free response field; or

the first request message is a register grant-free request message, and the first response message is a registration response message.

14. The method according to any one of claims 10 to 13, wherein the decapsulating and decrypting, by the core network device, the data according to the user equipment identifier and the key comprises:

decapsulating and decrypting, by the core network device, the data at an adaptation layer of the core network device by using the user equipment identifier and the key.

15. The method according to any one of claims 10 to 14, wherein the core network device is an independent physical device with a low-delay service function, or the core

network device is a mobility management entity, wherein the mobility management entity comprises a low-delay service function entity.

Embodiment 4: wherein the first request message is a non-access stratum message/an attach message, the non-access message/attach message comprises a register grant-free request field, the first response message is a non-access accept message/an attach accept message, and the non-access accept message/attach accept message comprises a register grant-free response field; or

the first request message is a register grant-free request message, and the first response message is a registration response message.

Embodiment 5: wherein the core network device is an independent physical device with a low-delay service function, or the core network device is a mobility management entity, wherein the mobility management entity comprises a low-delay service function entity.

Embodiment 6: 31. A core network device, comprising:

a receiving module, configured to receive, from an access network device, data transmitted by user equipment on a first contention transmission unit in a grant-free transmission mode, wherein the data is encrypted and encapsulated by using a key and a user equipment identifier that are allocated by the core network device to the user equipment and that are used for grant-free transmission;

a decapsulation module, configured to decapsulate the data according to the user equipment identifier;

a decryption module, configured to decrypt the data according to the key; and

a sending module, configured to send the decrypted data to a destination address in the data.

32. The core network device according to claim 31, further comprising an allocation module, wherein

the receiving module further receives a first request message from the user equipment by using the access network device, wherein the first request message is used to indicate that the user equipment supports grant-free transmission and to request the core network device to allocate, to the user equipment, the user equipment identifier and the key that are used for grant-free transmission; the allocation module allocates, to the user equipment, the user

equipment identifier and the key that are used for grant-free transmission; and the sending module further sends a first response message to the user equipment by using the access network device, wherein the first response message carries the user equipment identifier and the key.

33. The core network device according to claim 31 or 32, further comprising a generation module, wherein the generation module generates a pair of a public key and a private key; the sending module further sends the public key to the user equipment by using the access network device; and the decryption module further decrypts, by using the private key, the first request message that comprises the public key.

34. The core network device according to any one of claims 31 to 33, wherein the first request message is a non-access stratum message/an attach message, the non-access message/attach message comprises a register grant-free request field, the first response message is a non-access accept message/an attach accept message, and the non-access accept message/attach accept message comprises a register grant-free response field; or the first request message is a register grant-free request message, and the first response message is a registration response message.

35. The core network device according to any one of claims 31 to 34, wherein the decapsulation module decapsulates the data at an adaptation layer of the core network device by using the user equipment identifier and the key, and the decryption module decrypts the data at the adaptation layer of the core network device by using the key.

36. The core network device according to any one of claims 31 to 35, wherein the core network device is an independent physical device with a low-delay service function, or the core network device is a mobility management entity, wherein the mobility management entity comprises a low-delay service function entity.

37. An access network device, comprising:

a receiving module, configured to receive a first request message from the user equipment, wherein the first request message is used to indicate that the user equipment supports grant-free transmission and to request a core network device to allocate, to the user equipment, a user equipment identifier and a key that are used for grant-free transmission; and

a sending module, configured to send the first request message to the core network device, wherein the receiving module further receives a first response message sent by the core network device, wherein the first response message carries the user equipment identifier and the key; the sending module further sends the first response message to the user equipment, so that the user equipment encrypts and encapsulates data by using the key and the user equipment identifier; the receiving module further receives the data transmitted by the user equipment on a first contention transmission unit CTU resource in a grant-free transmission mode; and the sending module further sends the data to the core network device.

38. The access network device according to claim 37, wherein the receiving module further receives the first request message transmitted by the user equipment on a second CTU resource in multiple CTU resources.

39. The access network device according to claim 37 or 38, wherein the receiving module further receives a public key from the core network device; the sending module further broadcasts the public key in a system information block SIB message; the receiving module receives the first request message encrypted by the user equipment by using the public key, and sends the encrypted first request message to the core network device; and the receiving module receives the first response message encrypted by the core network device by using a private key.

40. The access network device according to claim 38 or 39, wherein the sending module further sends indication information of the multiple CTU resources to the user equipment.

41. The access network device according to any one of claims 37 to 40, wherein the first request message is a non-access stratum message/an attach message, the non-access message/attach message comprises a register grant-free request field, the first response message is a non-access accept message/an attach accept message, and the non-access accept message/attach accept message comprises a register grant-free response field; or the first request message is a register grant-free request message, and the first response message is a registration response message.

42. The access network device according to any one of claims 37 to 41, wherein the core network device is an independent physical device with a low-delay service function, or the core network device is a mobility management entity, wherein the mobility management

entity comprises a low-delay service function entity.

CLAIMS

1 A method for grant-free transmission, comprising:

obtaining (410), by a user equipment, a user equipment identifier and a key that are allocated by a core network device and that are used for grant-free transmission;

encrypting and encapsulating (420), by the user equipment, data by using the key and the user equipment identifier; and

transmitting (430), by the user equipment, the encrypted and encapsulated data to an access network device on a first contention transmission unit, CTU, resource in a grant-free transmission mode.

2 The method according to claim 1, wherein the obtaining, by user equipment, a user equipment identifier and a key that are allocated by a core network device and that are used for grant-free transmission comprises:

sending, by the user equipment, a first request message to the core network device by using the access network device, wherein the first request message is used to indicate that the user equipment supports grant-free transmission and to request the core network device to allocate, to the user equipment, the user equipment identifier and the key that are used for grant-free transmission; and

receiving, by the user equipment by using the access network device, a first response message sent by the core network device, wherein the first response message carries the user equipment identifier and the key.

3 The method according to claim 2, wherein the transmitting, by the user equipment, the encrypted and encapsulated data to an access network device on a first CTU resource in a grant-free transmission mode comprises:

selecting, by the user equipment, the first CTU resource from multiple CTU resources, and mapping the encrypted and encapsulated data to the first CTU resource for transmission.

4 The method according to claim 3, wherein the method further comprises:

selecting, by the user equipment, a second CTU resource from the multiple CTU resources, wherein

the sending, by the user equipment, a first request message to the core network device by using the access network device comprises:

mapping, by the user equipment, the first request message to the second CTU resource to send the first request message to the access network device, so that the access network device sends the first request message to the core network device.

5 The method according to any one of claims 2 to 4, before the sending, by the user equipment, a first request message to the core network device by using the access network device, further comprising:

receiving, by the user equipment, a system information block, SIB, message that is broadcast by the access network device, wherein the SIB message comprises a public key generated by the core network device; and

encrypting, by the user equipment, the first request message by using the public key, wherein

the sending, by the user equipment, a first request message to the core network device by using the access network device comprises:

sending, by the user equipment, the encrypted first request message to the core network device by using the access network device.

6 The method according to any one of claims 3 to 4, further comprising
comprising:

receiving, by the user equipment, indication information of the multiple CTU resources that is sent by the access network device.

7 The method according to any one of claims 1 to 6, wherein the encrypting and encapsulating, by the user equipment, data by using the key and the user equipment identifier comprises:

encrypting and encapsulating, by the user equipment, the data at a transport adaptation layer of the user equipment by using the key and the user equipment identifier.

8 A method for grant-free transmission, comprising:

receiving (610), by an access network device, a first request message from a user equipment, wherein the first request message is used to indicate that the user equipment supports grant-free transmission and to request a core network device to allocate, to the user equipment, a user equipment identifier and a key that are used for grant-free transmission;

sending (620), by the access network device, the first request message to the core network device;

receiving (630), by the access network device, a first response message sent by the core network device, wherein the first response message carries the user equipment identifier and the key;

sending (640), by the access network device, the first response message to the user equipment;

receiving (650) on a first contention transmission unit, CTU, resource in a grant-free transmission mode from the user equipment, by the access network device, data encrypted and encapsulated by the user equipment using the key and the user equipment identifier ; and

sending (660), by the access network device, the data to the core network device.

9. The method according to claim 8, wherein

the receiving, by an access network device, a first request message from the user equipment comprises:

receiving, by the access network device, the first request message transmitted by the user equipment on a second CTU resource in multiple CTU resources.

10. The method according to claim 8 or 9, further comprising:

receiving, by the access network device, a public key from the core network device; and

broadcasting, by the access network device, the public key in a system information block, SIB, message, wherein

the sending, by the access network device, the first request message to the core network device comprises:

receiving, by the access network device, the first request message encrypted by the user equipment by using the public key, and sending the encrypted first request message to the core network device; and

the receiving, by the access network device, a first response message sent by the core network device comprises:

receiving, by the access network device, the first response message encrypted by the core network device by using a private key.

11 User equipment (1100), comprising:

an obtaining module (1110), configured to obtain a user equipment identifier and a key that are allocated by a core network device and that are used for grant-free transmission;

an encryption module (1120), configured to encrypt data by using the key;

an encapsulation module (1130), configured to encapsulate the data by using the user equipment identifier; and

a sending module (1140), configured to transmit the encrypted and encapsulated data to an access network device on a first contention transmission unit, CTU, resource in a grant-free transmission mode.

12 The user equipment according to claim 11, wherein the obtaining module is configured to send a first request message to the core network device by using the access network device, wherein the first request message is used to indicate that the user equipment supports grant-free transmission and to request the core network device to allocate, to the user equipment, the user equipment identifier and the key that are used for grant-free transmission; and the obtaining module is configured to receive from the access network device a first response message sent by the core network device, wherein the first response message carries the user equipment identifier and the key.

13 The user equipment according to claim 12, wherein the sending module is configured to select the first CTU resource from multiple CTU resources, and map the encrypted and encapsulated data to the first CTU resource for transmission.

14 The user equipment according to claim 13, wherein the sending module is further configured to select a second CTU resource from the multiple CTU resources, and map the first request message to the second CTU resource to send the first request message to the access network device.

15 The user equipment according to any one of claims 12 to 14, wherein before the user equipment sends the first request message to the core network device by using the access network device, the obtaining module is further configured to receive a system information block, SIB, message that is broadcast by the access network device, wherein the SIB message comprises a public key generated by the core network device; the encryption module is configured to encrypt the first request message by using the public key; and the sending

module is configured to send the encrypted first request message to the core network device by using the access network device.

16 The user equipment according to any one of claims 13 to 14 wherein the obtaining module is further configured to receive indication information of the multiple CTU resources that is sent by the access network device.

17 The user equipment according to any one of claims 12 to 16, wherein the encryption module is configured to encrypt the data at a transport adaptation layer of the user equipment by using the key; and the encapsulation module is configured to encapsulate the data at the transport adaptation layer of the user equipment by using the user equipment identifier.